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MUSEUM OF COMPARATIVE ZOOLOGY,

AT HARVARD COLLEGE.

No. V.

THE IMMATURE STATE OF THE ODONATA.

PART I.—SUBFAMILY GOMPHINA.

BY

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P R E F A C E .

THE description of the immature state of the species belonging to the subfamily Gomphina is to be followed by that of the other five subfamilies of the interesting family of the Odonata. The materials in the collection of the Museum of Comparative Zoölogy are very rich, as is well shown by the Gomphina. Up to this time two species only have been published, both from Europe; now seventeen are described, viz. eleven from America, of which four are from South America, three from Asia, and three from Europe. The relation of the larvae described to the actually described imagos is, of course, very small. Baron De Selys Longchamps, in Liège, describes in his monograph of the Gomphina, published with my collaboration, and in the two additions, one hundred and seventy species,—just ten times more than the seventeen immature species here published. But of the six legions of the Gomphina two only are not represented in this monograph,—Chlorogomphus with one species from Japan, and Petalura with three species from New Holland and North America.

Of the species described, only four are raised and identified beyond any doubt, viz. *G. vulgarissimus*, by Dr. F. Brauer; *M. spiniceps*, by Mr. Fr. G. Sanborn; *H. breristylus*, by the late Dr. T. W. Harris; *C. bidentatus*, by Dr. F. Brauer. All the others are determined by exclusion or supposition, and some of them more or less doubtfully. The general character of the subfamily will be better given with the publication of the nearly related *Æschnina*.

I am responsible in this monograph for the determination of the species, as Mr. L. Cabot had not studied the imago before, and for the synopsis, taken from his descriptions.

H. A. HAGEN.

July 5, 1871.

B I B L I O G R A P H Y.

1712. REAUMUR, Mém., T. VI., pl. 37, f. 2 to 8, p. 403, figured and described the nympha of a French Gomphus. The figures are not sufficient to determine the species.
1749. ROESEL, Insectenbelustigung, T. II., P. II., pl. 7, f. 1, 2, gives the larva and nympha of a Gomphus, perhaps *G. vulgarissimus*. Roesel believes it to belong to *Lithellula depressa* or *L. cancellata*, but he states that he had several different species in the same jar, and the figured one is surely a Gomphus. The larva described by Scopoli, Fauna Carniolica, p. 259, as belonging to *Corduligaster annulatus*, is surely an Æschna, and not a Gomphus.
1839. BURMEISTER, Handbuch, T. II., p. 831, gives a short notice on the larvæ of the Gomphus.
1853. H. HAGEN, Stettin, Ent. Zeit., T. XIV., p. 263, describes *G. vulgarissimus* and *C. bidentatus*, both raised by Dr. F. Brauer.
1857. F. BRAUER, Neuroptera Austriae, p. xv., describes both species raised by him, formerly communicated to Dr. Hagen.

O D O N A T A.

GOMPHINA.

1. *Herpetogomphus* species.

SELYS, Monogr. des Gomph., p. 69.

Plate I., fig. 2, b, c.

Locality: Brazil, Rio dos Macacos, Thayer Expedition. Nympha, male, full grown. Mus. Comp. Zool. Length, 31 mm.; breadth, 7 mm.

Body Eschna-like, rather flat, hairy. Head cordate, flat. Eyes moderately prominent. Ocelli developed; an oblique groove extending from lateral ocellus to front angle of eye; part behind the eyes short, notched at middle, with flat spot on each side; hind angles rounded with circular tubercles. Antennæ, two basal joints short, globular; 3d long, dilated, straight, bent up a little at tip; 4th joint very short, rudimentary. Mask extending to fore legs; breadth half the length, narrower behind, sides bent up; somewhat marginated; middle third of fore-border produced in rounded lobe edged with bristles, and having two small black teeth on each side of middle. Palpi small, not meeting, finely denticulated; end hooks sharp, bent down; movable hooks long, arcuated. Prothorax narrower than head, with short anterior lobe; posterior part rounded, has two quadrangular impressions. Wing-cases reaching middle of fourth segment. Legs short and strong, formed for burrowing. Hind legs more distant at base. Fore and middle legs alike; femora and tibiae strong, somewhat bent; tibiae longest; tarsi less than $\frac{1}{2}$ as long as tibiae, 2-jointed, basal joint very small; claws small, sharp. Hind legs reaching 9th segment, rather flattened; tarsi 3-jointed. Abdomen long, gradually narrowing to tip, somewhat rounded above and flattened below. Segments 2 to 9 have dorsal hooks, thicker on 2d segment, nearly obliterated (accidentally?) on 6th, more marked on those following. Side-border sharp. Lateral spines on segments 7, 8, 9; Segments of equal length, 10th segment a little longer than 9th. Anal appendices long, sharp, pyramidal, 2 inferior ones as long as 10th seg.; superior a little shorter, basal half thickened above; lateral appendices $\frac{1}{2}$ as long as inferior.

As this nympha is very similar to *Gomphus*, it probably belongs to *Herpetogomphus*, which is found in South America, while *Gomphus* is not.

There is in same collection and from same locality a larva 5 mm. long, wing-eases just visible; more hairy; teeth on lobe of mask; inside of palpus more marked; dorsal hooks just visible; middle anal appendix not thickened at base.

2. *Gomphus pilipes.*

SELYS, Monogr. des Gomph., p. 148.

Plate I., fig. 3, a, b, c.

Nympha, full-grown female. Locality: S. Carolina. Coll. Hagen. Museum Comp. Zool. Length, 25 mm.; breadth, 10 mm.

Body flat, lanceolate, sparingly covered with hairs. Head cordate, flat. Eyes rather prominent, large. Ocelli developed. Vertex flat, an oblique groove extending from lateral ocellus to front angle of eye. Antennae, two basal joints globular, 2d a little shortest, 3d twice as long as both basal, straight, 4th rudimentary. Part behind eyes short, notched at middle, hind angles rounded, 2 flat tubercles near hind-border. Mask reaching fore legs, small, oblong, sides bent up; fore border produced at middle third in small rounded lobe, with comb of bristles. Palpi short, not meeting; end hook not longer than denticulations; movable hooks thin, sharp, long. Prothorax narrow, oval, border elevated at sides. Wing-eases reaching to middle of 4th segment. Legs strong, hairy, formed for burrowing. Hind legs more separated at base. Fore and middle legs of equal size, short; femora short, strong, arcuated; tibiae a little longer, nearly straight; tarsi very short, 2-jointed. Hind legs reaching 8th seg., flat; tarsi 3-jointed; claws short, sharp. Abdomen flat, broad, narrowing after 6th segment. Segments 9 and 10 very contracted. Segments have three spots on each side, 9th a linear spot. No dorsal hooks. Segments 8 and 9 have lateral spines. Side-border sharp. Segments of equal length except two last; 9th longer than 8th; 10th $\frac{1}{2}$ as long as 9th; nearly cylindrical. Anal appendices very short, not $\frac{1}{2}$ as long as 10th segment, pyramidal, sharp, nearly equal in length. Two lateral a little shorter. A small bifid tubercle at end of eighth ventral segment.

Another specimen from South Carolina, Coll. Hagen, is identical, but smaller; 25 mm.

These nymphæ are, of course, only referred to *G. pilipes* as probably belonging there or to a related species.

3. *Gomphus vulgatissimus.*

SELVY, Monogr. des Gomph., p. 129.

Plate I., fig. 1, b, c.

Nympha, male. Length, 31 mm.; breadth, 8 mm. Locality: Europe. Raised by Dr. Brauer, female. Coll. Hagen.

Head cordate, flat. Eyes large, prominent. Ocelli developed. Oblique groove extending from lateral ocellus to front angle of eye. Vertex square, a little elevated. Part behind the eyes short, notched at middle; small elevated spots behind eyes. Antennæ, two basal joints short, globular, 2d shortest, 3d nearly twice as long as both basal, dilated, somewhat bent up at tip, 4th rudimentary. Mask reaching to the fore legs, quadrangular, channeled in middle, sides bent up, cut straight at fore-border, middle third finely denticulated, and surmounted by comb of bristles. Palpi short, arenated, finely denticulated at basal half, end hook stout; movable hooks long and sharp. Prothorax oval, fore-border elevated, a flat impression on each side. Wing-cases reaching nearly to 4th segment. Legs strong, formed for burrowing. Hind legs more widely separated at base. Fore and middle legs short, about equal size. Femora short, stout, bent inward; tibiae longer, with strong outer spine at anterior end; tarsi 2-jointed, short, basal joint very short, claws sharp. Hind legs longer, reaching nearly to 9th segment, flat; tarsi 3-jointed, 2d, half the length of 3d. Abdomen long, flat, lanceolate, decreasing in size after 6th segment. Side-border sharp; segments 2 to 9 with large flat spots. No dorsal hooks. Segments 6 to 9 with lateral spines; spines of 9th $\frac{1}{2}$ as long as 10th segment. Segments of equal length, except 10th, which is small, about $\frac{1}{3}$ of foregoing, and cylindrical. Anal appendices a little longer than last segment, pyramidal, sharp. Superior one thickened at basal half; lateral superior ones shorter, sharp.

Have seen both sexes. Female has abdomen a little broader, and at end of 8 ventral segment a small bifid tubercle, superior appendix not thickened at basal half.

4. *Gomphus species.*

Plate II., fig. 4, b.

Nympha, 31 mm.; breadth, 6 mm.

Locality: Rock Island, Illinois. Coll. Hagen. Mr. Walsh supposed this nympha, judging from perfect insects found in vicinity, to belong either to *G. vastus*, *fluvialis*, *amnicola*, or *fraternus*.

Very similar to *Gomphus vulgatissimus*, differs in having less prominent tubercles on occiput. Denticulation of palpi deeper. Wing-cases reaching 4th segment. Abdomen considerably narrower, more rounded above; 8th and 9th segments with tubercles on dorsal line, lateral spines on 9th longer than 10th segment, which is very short; 9th segment a little longer than 8th. Anal appendices a little shorter than in *G. vulgatissimus*. Hind legs extending to 8th segment only.

5. *Gomphus* species.

Plate II., fig. 5.

Nympha full grown, 24 mm. long, 6 mm. broad, similar to *G. vulgatissimus*. Locality: Massachusetts. Coll. Mus. Comp. Zoöl., and Coll. Hagen.

Body tapering less abruptly. Head with flat spots instead of tubercles on occiput. Wing-cases reaching middle of 4th segment. Legs rather more slender. Dorsal hooks on segments 6 to 9; on the other segments rudimentary. Lateral spines on segments 7 to 9; 9th segment longer than 8th, with lateral spines nearly as long as 10th, which segment is rather longer than in *G. vulgatissimus*.

There is another, from same collection, younger, 21 mm. long.

6. *Gomphus* species.

Plate II., fig. 6, b.

Nympha. Length, 24 mm.; breadth, 7 mm.

Locality: Pole Creek, W. Texas. Coll. Hagen.

Body flat. Head flat, cordate. Eyes rather prominent. Ocelli developed. Part behind eyes rounded. Antennae, two basal joints globular, 2d smallest, 3d elongated and enlarged, 4th small, rudimentary. Whole head granulated. Mask extending to fore legs, length greater than breadth, moderately channelled in middle, middle third somewhat produced, with comb of bristles. Palpi enlarged and rounded at ends, very finely denticulated. Movable hooks long and sharp. Wing-cases extending to middle of 3d segment. Legs strong. Hind legs more separated at base. Middle and fore legs of nearly equal size, strong, formed for burrowing. Femora and tibiae arcuated. Tibiae with strongly marked end spine; tarsi 2-jointed; claws sharp. Hind legs reaching 9th segment; tarsi 3-jointed. Abdomen flat, tapering. Dorsal hooks on all segments except 10th. Lateral spines on segments 7 to 9. Segments of nearly equal length. Lateral spines of 9th much

shorter than the 10th segment. Anal appendices longer than 10th segment, pyramidal, sharp, of nearly equal length. Lateral superior appendices nearly as long as the others.

7. *Gomphus* species.

Plate II., fig. 2, b, c, d.

Nympha, full grown. Length, 22 mm.; breadth, 7 mm.

Locality: Himalaya, Ghugger Pir, Rev. M. M. Carleton. Coll. Mus. Comp. Zoöl.

Body flat, lanceolate. Head cordate. Eyes large, very prominent. Ocelli indistinct. Vertex flat, two small impressions at fore part. Part behind the eyes short, rounded laterally; hind angles blunt; two flat impressions on each side of median line. Antennæ, two basal joints globular, 2d smallest, 3d long, dilated, bent up, 4th very small, black, cylindrical. Mask extending to fore legs, length greater than breadth, narrower behind, deeply channelled at fore-border, sides bent up; middle 3d of fore-border produced in elliptical lobe, deeply cleft in the middle, with comb of bristles thickened at base. Palpi strong, with sharp, bent hooks; some molar incisions; movable hooks long, bent, sharp. Prothorax oval, narrower than head, rounded, flat. Wing-cases reaching 4th segment. Legs formed for burrowing. Hind legs more widely separated at base. Fore and middle legs stout, about equal in size. Femora and tibiae arcuated, tibiae are without the sharp lateral spine at end; tarsi knife-shaped, 2-jointed; claws sharp. Hind legs tarsi 3-jointed, straight. Abdomen flat, dorsum slightly rounded, tapering gradually. Side border sharp. Segments 5 to 9, with lateral spines; no dorsal hooks. Segments of nearly equal length, 10th small, short, cylindrical. Lateral spines of 9th are $\frac{1}{2}$ length of 10th. Anal appendices a little longer than 10th; equal length, pyramidal, sharp. Superior appendix with two tubercles near the tip. Lateral short and sharp.

8. *Macrogomphus spiniceps*.

Nat. Hist. Soc., Phil., 1862, p. 889.

Plate II., fig. 1, a, b, c.

Nympha. 41 mm. long; 8 mm. broad.

Locality: Taken in transformation by Mr. F. G. Sanborn, July 4, 1867, at Lawrence, Mass.

Body long, narrow. Head cordate. Eyes large, prominent. Ocelli developed. Antennae, somewhat shorter than head, two basal joints short, globular; 3d twice as long as two preceding, dilated, bent inward at tip, 4th joint rudimentary. Vertex flat; outside of ocelli are visible small tubercles, apparently where the spines of imago are placed. Mask extending to fore legs, somewhat longer than broad, channelled in middle; fore-border a little broadest, cut straight; middle 3d with comb of short hairs. Palpi short, strong, arcuated; tip forming strong bent hook, denticulated just before the end; movable hook as long as palpus, sharp. Prothorax somewhat smaller than head, nearly square, narrowed a little in front, sides and angles rounded; two flat impressions near the front and hind borders. Wing-cases nearly reaching the 4th segment. Legs short, strong, hairy. Hind legs more separated at base: fore and middle legs of equal length, shorter than hind legs; femora very short, bent; tibiae similar and longer; tarsi nearly $\frac{1}{2}$ as long as tibiae, 2-jointed; claws bent; the outside claw shorter and stronger than inner one. Hind legs reaching 6th segment, nearly straight, tarsi 3-jointed; basal joint short, two others of about equal length. Legs formed for burrowing. Abdomen somewhat conical, tapering. Segments 1 to 8 nearly equal length, 9th nearly twice as long, narrowed in middle; 10th short and slender; large flat spots on segments 2 to 8; segments 6 to 9 with lateral spines. No dorsal hooks. Anal appendices as long as 10th segment, pyramidal, the two lower broader, not very sharp. All of equal length and like shape.

Male nympha has sexual parts visible on 2 and 3 ventral segments; the opening of sexual parts on middle of 9th; in the female a bifid knob on the articulation between 8 and 9 is visible.

9. *Progomphus?? species.*

SELYS, Monogr. des Gomph., p. 194.

Plate II., fig. 3, a, b, c.

Nympha, full grown male and female. Length, 30 mm.; breadth, 7 mm. Looks rather like *Aeschna*.

Locality: Wareham, Mass. Mus. Comp. Zoöl.

Head stout, rather square, narrowed forward. Eyes not very prominent. Ocelli very well developed. Vertex flat, with irregular hairy spots. Antennae stout, two basal joints small, globular, 3d long, dilated, very hairy, 4th small, $\frac{1}{4}$ length of 3d, cylindrical, recurved. Behind each eye a circular elevated spot, and between these, two impres-

sions on occiput. Mask extending to fore legs, narrow; length twice the breadth; somewhat enlarged forward, with middle channel widening forward; front border produced in semicircular lobe, edged with hairy comb; the hairs forming this are enlarged at tip and flattened, inserted in small basal cylinder. Palpi short, bent, ending in blunt hooks, smooth inside; movable hooks long, sharp. Prothorax nearly circular, rounded at fore-border, with two oblique impressions: side-border very slightly raised; prothorax polished, shining, near borders and middle line slightly granulated. Wing-cases extending beyond 4th segment. Legs stout, short, hairy, typical burrowing legs. Hind legs much more widely separated at base than fore and middle legs; middle legs nearer at base than fore legs. Fore legs somewhat stronger than middle legs, the coxae being highly developed, and the femora triangular, arcuated and dilated at base. Tibiae thickened at middle, near the end bent and narrowed; tarsi somewhat shorter and bent up; 1st joint very short, 2d long, knife-shaped; hooks stout, rather blunt, outer hook rather shortest. Middle legs similar in shape, coxae smaller, femora narrowed at base. Hind legs reaching 8th segment, similar in shape to the other legs, flatter. Tarsi 3-jointed, longer than tibiae; claws sharp.

Abdomen as in *Aeschna*, venter flattened, dorsum rounded, largest at 5th segment, tapering toward end. Segments 1 to 9 with strong dorsal hooks. Side-border sharp. Segments 5 to 9 have lateral spines. 9th and 10th ventral segments not hollowed beneath, polished. The three anal appendices rather longer than 10 segment, pyramidal, sharp, of equal length; two lateral ones half as long, blunt, pyramidal.

This nympha is distinguished by highly developed burrowing legs, fore legs strongest; coxae, femora, and tarsi much developed. Middle legs are nearest together at base, a peculiarity also distinguishable in *Gomphoides*. Hind legs highly developed. Abdomen exactly like *Aeschna*. Segments of equal length, 10th perhaps a little shorter. Ventral 9th not making part of the hollow of rest of abdomen; stigmata placed outside of hind angles of prothorax. Shape of antennae and mask refer this nympha to Legion *Gomphoides*. It might be supposed to belong to genus *Progomphus*, if that genus were found in New England.

A female nympha not fully grown, 25 mm. length, precisely like foregoing, but darker in color, from Carundahy, Brazil. Thayer Exp., is in the coll., unless some mistake in locality has been made in the label.

10. Gomphoides species.

SELYS, Monogr. des Gomph., p. 208.

Pl. I., fig. 5, a, b, c, d.

Nympha, male. Length, 36 mm.; breadth, 6 mm. Skin split, showing the imago.

Locality: Sta Cruz, Brazil. Thayer Exp. Mus. Comp. Zoöl.

Body long, slender. Head cordate, hairy, nearly as broad as the body. Eyes large, prominent. Ocelli well developed. Antennae rather short, two basal joints globular; 3d twice as long, strong, dilated; 4th short, linear. Vertex flat; in front of anterior ocellus an impression; behind the eyes on occiput an oval depressed spot. Mask reaching half-way between fore and middle legs. Breadth half the length, enlarged in front, middle much produced in semicircular lobe, with fringe of bristles. Palpi short, arcuated, not denticulated; movable hooks longer than palpus and sharp. Prothorax oblong, breadth rather greater than length, sides and angles rounded; two oblique impressions in front and one behind at middle. Wing-cases reaching middle of 4th segment. Legs short, strong, hairy; hind legs more widely separated at base; fore and middle legs of equal size; femora stout and arcuated, enlarged at middle; tibiae somewhat longer, angular. Tarsi shorter, basal joints very small, 2d longer, knife-shaped, bent outward; claws very small, strong, rather blunt; tibiae and tarsi have black spines on outer side. Legs formed for burrowing. Hind legs more slender, reaching 6th segment; femora and tibiae straight; tarsi 3-jointed, 2d shorter than 3d, claws longer, pointed. Abdomen conical, venter less rounded than dorsum, tip extremely tapering. Segments of nearly equal length, gradually decreasing, except 10th, which is longer than 7th, 8th, and 9th together, and nearly cylindrical. Side-edges rather prominent. Segments 7, 8, and 9 have lateral spines. Segments 4, 5, and 6 have dorsal spines, strongest on 4 and 5. Anal appendices pyramidal, short, sharp, all five of equal length. Sexual parts are visible on 2 and 3 ventral segments.

This nympha belongs perhaps to the genus *Gomphoides* (sub-genus *Aphylla*) *brevipes* Selys, the imago of which has the 10th segment of equal length to 9th, while the others, from Brazil, have 10th segment shorter. A nearer determination is not at present possible.

11. *Gomphoides* species.

There are three female nymphæ, not quite full grown, belonging to a different species, similar to the foregoing and somewhat smaller, differing in having dorsal spines on segments 4 to 9. Locality: Rio dos Macaeos, Brazil. Thayer Ex. Mus. Comp. Zoöl.

HAGENIUS.

SELYS, Monogr. des Gomph., p. 238.

Body exceedingly flat, nearly circular. Head cordate. Eyes set at back of head. Antennæ very peculiar: two basal joints short, cylindrical; 3d flat, dilated, plate-shaped; 4th very rudimentary, not to be seen unless much magnified. Mask extending to fore legs, square, flat, bent up at sides, front border produced at middle. Palpi small, inner border not dentiulated, tip rounded, blunt; movable hook sharp, somewhat longer than palpus. Middle legs more separated at base than fore legs; formed for running. Abdomen very flat, enlarged, nearly circular. The outer edges of segments forming a sharp-edged border, separated from abdomen by marked ventral ridge. 9th segment longer than 8th, 10th small, cylindrical, and entirely inserted in 9th. Anal appendices a little longer than 10th segment.

12. *Hagenius brevistylus*.

SELYS, Monogr. des Gomph., p. 241, No. 86.

Plate III., fig. 4, a, c, d.

Locality: North America. I have seen 8 nymphæ, very young and full grown, length, 12 mm. 40 mm., from Massachusetts, New York, and Osage, Kansas, all females. In the collection of the late Dr. T. W. Harris, in the Boston S. N. H., is preserved the skin of a nympha with the imago raised by him. Coll. Mus. Comp. Zoöl. Coll. Harris. Coll. Hagen.

Body very flat, broad. Head cordate, flat, breadth and length equal; between the antennæ a narrow projection, with rectangular notch at front, inserted in which a cordate tubercle. Eyes situated at hind part of head, moderately large. Antennæ short, broad; the 2 basal joints short, 3d much dilated, flat, circular, with inner edge cut straight; border somewhat elevated, covered with short scale-like hairs; at the

tip a rudimentary 4th joint, only to be seen when much magnified. Vertex flat, ocelli visible. Occiput short, hind-border notched; median line impressed, on each side a small conical tubercle; lateral hind-angles elevated, pyramidal. Mask square, somewhat produced at fore-border. Palpi small, not denticulated, blunt: hook sharp, longer than the palpus. Prothorax narrow, excavated, hind border a little rounded; a transverse impression near fore-border. Legs formed for running, flat, slender. The fore and middle legs short; the fore legs shortest; femora flattened, edged with white hairs: tibiae angular, longer than femora; tarsi half as long as tibiae, 2-jointed, basal joint very short. Hind legs long, femora reaching nearly to 7th segment; tibiae of equal length to femora, tarsi 3-jointed, basal short, 2d longer, 3d equal to both in length. Wing-cases reaching 6th segment. Abdomen lanceet-shaped, exceedingly flat, broader than head, nearly circular, dorsum somewhat elevated. Segments of nearly equal length, excepting 10th, which is very small and inserted in 9th. Segments 5 to 6 broadest, the others decreasing, the 9th nearly triangular. The outer edges of segments 2 to 8 form border, sharp and pointed at hind angles. Dorsal hooks prominent, flattened laterally and bent backward, less prominent on 7th to 9th segments. Anal appendices short, stout, pyramidal, blunt, a little longer than 10th segment. Superior somewhat shorter, channelled at sides, lateral very small, half as long as the others. The 8th ventral segment has small bifid vulva lobe.

13. *Hagenius (Sieboldius) japonicus.*

SELYS, Monogr. des Gomph., p. 244, No. 87.

Plate III., fig. 5, c.

Locality: Kanagawa, Japan. Coll. Mus. Comp. Zool. One nympha, male, not full grown. Length, 28 mm.

Very similar to *H. brevistylus*, differs as follows: Head a little shorter; hind end of the part between antennae less deeply notched; inserted tubercle rounded; 3d joint of antennae not so rounded. Hind angles of occiput blunt. Abdomen straighter at sides, 9th segment shorter; lateral angles of 9th not so sharp. Dorsal hooks modified in flattened tubercles. Anal appendices sharper, superior bluntest, not so deeply channelled at sides; the tip seems to be broken, before the tip are three rounded tubercles; perhaps this is a sexual character; wing-cases reaching to middle of 3d segment only. As a species *Hagenius japonicus* is found in Japan, this nympha is supposed to be the incomplete insect.

14. *Ictinus* species.

SELYS, Monogr. des Gomph., p. 263.

Plate I., fig. 4, a - e.

Nympha, male. Length, 23 mm.; breadth, 10 mm. Locality: doubtful. Coll. Hagen; middle Himalaya, Rev. M. M. Carleton. Coll. Mus. Comp. Zool.

Body short, stout, roof-shaped. Head large, cordate, with straight line behind the eyes; the fore part of head, including eyes, triangular, nearly equilateral; part behind the eyes half as long as that before, narrower next the prothorax. Eyes rather prominent, moderately large, triangular; part between the eyes same breadth as eyes. Sides of the head, with small prominent tubercles below the eyes. Ocelli developed. Vertex flat, sloping forward. Antennæ shorter than the head, 2 basal joints globular, 2d half the size of 1st; 3d twice as long as the two preceding, dilated, flat above. At under side of tip a small tubercle, perhaps rudimentary 4th joint. Occiput rather rounded above, sides oblique, hind border notched in middle, hind angles rather blunt. Upper lip stout, broad; base of mandibles heavy, not covered by upper lip; the basal part of head below the mandibles forming a point at each side; basal part of maxilla not covered by mask. Mask extending between the fore legs, large, nearly square, a little smaller behind; flat, sides bent up; fore-border nearly straight, middle 3d a little produced, slightly denticulated. Palpi short, with bent and rather blunt point, inside finely denticulated; movable hooks long, sharp, arrenated. Prothorax not so broad as head, in general shape semicircular; fore-border forms transverse triangular lobe; hind-border thickened and bent up; the prothorax forms at sides beneath the eyes a protuberance. Meta and mesothorax coming together in elevated ridge. Wing-cases reaching 7th segment. Legs long, slender, formed for running; hind legs more separated at base than the others; femora of fore legs a little arcuated; tibiae angular, somewhat longer; tarsi $\frac{1}{2}$ as long as tibiæ, basal joints very small, hooks strong and sharp. Middle legs similar, but somewhat longer; hind legs a little longer than the abdomen, straight, flat. Tarsi only two joints, basal very short. Abdomen ovoid, base contracted, broadest at 7th segment, 8th and 9th rounded off toward end of abdomen. Dorsum elevated, roof-shaped. Median line in segments 7 to 9, elevated in flattened hooks, pointed at end of segments. Side-border of abdomen sharp, with lateral spines on segments 7 to 9, similar to Hagenius. Segments 2 to 5 short, following longer; 10th very short and entirely inserted in 9th, sides of segments 2 to 9 with

smooth spots. Anal appendices short, a little longer than spines of 9th segment, pyramidal, sharp, the lateral superior ones a little shorter, the superior middle one with two polished tubercles in the middle of the side-border, perhaps a sexual character. Abdomen beneath hollowed out, but shallow; edges of segments sharply defined.

This larva is extremely interesting. The 2-jointed tarsi of hind legs are exceptions in the whole family; the general shape of body is more like Libellulide. The antennae belong to *Gomphus*, and the mask also. Stigmata behind prothorax free. The whole body finely granulated. The figure and the description are taken from a dry specimen supposed to be from Brazil (the locality not given), and to belong perhaps to *Zonophora*. There has just arrived a collection from the middle Himalaya, Sutledge, sent by Rev. M. M. Carleton, containing several specimens in alcohol, all agreeing perfectly with the described specimen. It seems not impossible, indeed probable, that the species belongs to the genus *Ictiurus*.

CORDULEGASTER.

Head transverse, oblong. Eyes conical, placed at anterior lateral angles. Antennae seven articulated, filiform. Between the antennae the head forms a flat, semicircular projection. Mask extending a little beyond the middle legs, spoon-shaped, covering the mouth, upper lip, and front of head as far as the antennae. Palpi in general shape triangular, much dilated forward, and furnished at outer edge with long teeth of unequal length, slightly bent inward, and fitting closely in an irregular line into those of opposite palpus; movable hooks short, sharp, slender. Prothorax nearly as broad as head. Stigmata large, quite uncovered. Legs at base widely and equally separated; formed for running. Hind legs shorter than the body. Tarsi 3-jointed. Abdomen cylindrical above, flattened below, tapering at end like a sphinx pupa. Segments nearly equal in length, anal appendices rather long, pyramidal, sharp.

15. Cordulegaster Sayi.

SELYS, Synopsis des Gomphines, p. 85, No. 106; second additions, p. 40. Monogr. des Gomph. p. 331, No. 109.—*C. lateralis* Scudd., Proc. Boston S. N. H., X, p. 211.

Plate III., fig. 2.

Locality: Maryland; Cambridge and Chicopee, Mass. July 1-4, 1860. R. H. Wheatland. Length, 40 mm.

Head short, broad. Breadth twice the length, sides straight, rounded off behind so that the hind-border in front of prothorax is half the width of fore-border. Vertex flat. Hind-border somewhat indented. Eyes small, round, prominent, placed at forward lateral angles of fore border of head, with triangular piece projecting inward. Ocelli visible, especially the lateral ones. Antennæ 7-jointed, tapering, slender; the 2 basal joints thicker and more rounded, 3d longer than 2d; joints 3 to 7 form a rather slender seta. Mask large, extending a little beyond the middle legs, triangular, contracted behind; the sides bent up, hollowed back of fore-border, which is prolonged into a bifid tip, surmounted by a short hairy comb. Palpus broad, enlarged at inner border, and deeply denticulated, the denticulations of the opposite palpi closely fitting into one another; movable hook short, sharp, and slender. Prothorax half the length of head, and two thirds the breadth, indented in the middle, raised at fore part in small transverse lobe, at hind part border raised, and thicker in the middle. Stigmata large, open. Legs very hairy, flattened, formed for running. Femora angular, thick, and a little bent; tibiae about equal in length to femora. Tarsi 3-jointed, more than half as long as tibiae. 1st joint short, 3d longest; claws very sharp. Hind legs reaching the 7th segment. Abdomen long, rounded above, tapering gradually. Largest part at middle, as wide as head; no dorsal hooks. Segments 8 and 9 with lateral spines. Segments of about equal length. 3 anal appendices of twice length of 10th segment, pyramidal, sharp; superior somewhat shorter; lateral ones very short and sharp. At the end of 8th ventral segment a bifid triangular vulva nearly equal in length to 9th segment.

Have seen one not full-grown female nympha, length 30 mil., from Maryland, which is figured. Coll. Hag., and two full grown from Chicopee, Mass., length 40 mm. Coll. Mus. Comp. Zoöl.

It was thought best to refer this nympha to *C. Sayi*, as this is the only North American species very similar to *C. annulatus*.

16. *Cordulegaster annulatus.*

SELYS, Monogr. des Gomph., p. 333, No. 110.

Plate III., fig. 3.

Nympha, female, not full grown. Coll. Hagen. Locality, Lüneburg, Hannover; Mr. Heyer. Length, 30 mm.

Not to be distinguished from *C. Sayi*, but distinguished from *C. bidentatus* by having lateral spines on 8th and 9th segments, and by the length of superior anal appendix, which is, as in *C. Sayi*, of nearly equal length with lateral appendices. As the only species of *Cordulegaster* known in Europe are *C. bidentatus* and *C. annulatus*, this nympha is referred to the latter; *C. bidentatus* has not been found in the North of Germany.

17. *Cordulegaster bidentatus.*

SELYS, Monogr. des Gomph., p. 339, No. 112.

Plate III., fig. 1, a, b, c, d.

Nympha, female. Raised by Dr. Brauer. Locality, Vienna, Austria. Coll. Hagen. Length, 43 mm.

In most respects strikingly like *C. Sayi*; differs in having the sides of the head more straight, and less gradually sloped backward, making hind-border broader than *C. Sayi*; in having no lateral spines, and in the inferior length of superior anal appendix, which is one half the length of lateral appendices and blunt.

The figured specimen is described at some length by Dr. Hagen, in the *Stettin Entom. Zeit.*, XIV, p. 265, and by Dr. Brauer, *Nouv. Austr.*, p. xv.

SYNOPSIS OF THE SPECIES DESCRIBED.

SUB-FAMILY: **GOMPHINA.**

SELYS, Monogr. des Gomph., p. 6.

DIVISION I. **INTEGRILABIEES.** SELYS, Monogr. des Gomph., p. 6.

The under lip entire in the imago.

Head cordate; eyes in the middle of the lateral border of the head; antennæ, 4 articulated, 3d flat, dilated, 4th rudimentary; mask not covering the mouth, nor the upper lip. Legs not equally distant at base; burrowing legs, at least the fore and middle legs; tarsus 2 articulated in the fore and middle legs, 3 articulated in the hind legs, or 2 articulated (Lindenia). Abdomen flattened.

LEGIO I. **Gomphus.** SELYS, Monogr. des Gomph., p. 6.

Mask reaching the fore legs, quadrangular, somewhat longer than broad; palpus hooked at the tip, inside, or denticulated, or with molar incisions. Hind legs farther distant at base than the fore and middle legs, which are equally distant and fitted for burrowing. Abdomen lanceolate.

A. *Front border of the mask produced at middle third in a rounded lobe not cleft.*

Sub-genus: **Herpetogomphus.** SELYS, l. c., p. 69. (Supposition.)

1. **H. species.** Nympha, full grown and larva. Brazil, Rio dos Macacos.

Mask, breadth half the length, having two small black teeth on each side of middle of the front-border; palpus finely denticulated. Abdomen gradually narrowing to tip. Segments 2 to 9 with dorsal hooks; lateral spines on 7 to 9; segment 10 a little longer than 9; anal appendices as long as segment 10, the superior a little shorter; the lateral ones half as long as the inferiors.

Sub-genus: **Gomphus.** SELYS, l. c., p. 118.

2. **G. pilipes** (or a related species; supposition). SELYS, l. c., p. 148.

Nympha, full-grown female. South Carolina, U. S. Mask nearly square; end hook of palpus not longer than the denticulations. Abdomen flat. Segments 9 and 10 very contracted; no dorsal hooks; lateral spines on 8th and 9th segments; segment 10 half as long as 9; anal appendices very short, nearly of equal length, the lateral ones a little shorter.

3. **G. vulgarissimus**, LINNÉ. SELYS, l. c. p. 129.

Nympha, full-grown female and male. Europe. Raised by Dr. F. Brauer. Mask quadrangular, front-border middle third finely denticulated; palpus finely denticulated at basal half. Abdomen flat; no dorsal hooks; lateral spines on segments 6 to 9; anal appendices a little longer as 10th segment, the lateral ones a little shorter; lateral spines of 9th segment half as long as 10th segment.

4. **G. fraternus** (or **vastus**, or **fluvialis**, or **annicola** WALSH, supposition).

Nympha. Rock Island, Ill. Similar to **G. vulgarissimus**. Segments 8 and 9 with dorsal tubercles; lateral spines of segment 9 longer than segment 10.

5. **G. species.**

Nympha, full grown. Massachusetts. Similar to **G. vulgarissimus**. Spots instead of tubercles on occiput; dorsal hooks but little developed on segments 6 to 9; lateral spines on 7 to 9; segment 9 longer than 8, with lateral spines half as long as segment 10.

6. G. species.

Nympha. Pole Creek, Texas. Mask quadrangular, front border of the middle third finely denticulated; palpi blunt, very finely denticulated; abdomen with dorsal hooks on 2d to 9th; lateral spines on 7th to 9th; the lateral spines of segment 9 much shorter than segment 10; anal appendices longer than segment 10, sharp, of nearly equal length.

B. *Front border of the mask produced at middle third in a cleft lobe.*

Sub-genus: **Cyclogomphus.** SELYS, I. e., p. 105. (Supposition.)

7. G. Species.

Nympha, full grown. Himalaya, Ghugger Pur. Body flat; mask quadrangular, front-border produced at middle third in elliptical lobe, cleft in the middle, with comb of bristles thickened at base; palpus with molar incisions to the end hook. Abdomen flat; no dorsal hooks; lateral spines on 5th to 9th; lateral spine of segment 9 half as long as segment 10; anal appendices a little longer than segment 10, of equal length, sharp.

C. *Front border of the mask cut straight.*

Sub-genus: **Macrogomphus.** SELYS, I. e., p. 87. (Raised.)

8. M. spiniceps WALSH. Proc. N. H. Soc., Phila., 1862, p. 889.

Nympha, full-grown male and female. Lawrence, Mass. Raised by Mr. Fr. G. Sanborn. Body long, narrow; mask quadrangular, front border cut straight. Abdomen somewhat conical, tapering; segment 9th twice as long as the foregoing, narrowed in the middle; no dorsal hooks; segment 6 to 9 with lateral spines; anal appendices as long as the 10th segment, which is short and slender, of equal length, pyramidal.

LEGION II. Gomphoides. SELYS, I. e., p. 189.

The general character is not yet given, all species, except one, determined merely by supposition, the determination of some doubtful.

A. *Antennae with the third joint long, the fourth $\frac{1}{4}$ length of the third; middle legs nearer at base than fore legs.*

Sub-genus: **Progomphus?** SELYS, I. e., p. 191. (Supposition.)

9. Progomphus species?

Nympha, full-grown male and female. Wareham, Mass.; Carundahy, Brazil. There is no genus known to be living in both countries; Progomphus lives in Brazil, though the locality, Massachusetts, is doubtless correct. If the determination is erroneous, as is possible, no other seems more probable.

Body baneolate; antennae, 3d joint long, dilated; 4th small, cylindrical, $\frac{1}{4}$ length of 3d; mask reaching fore legs, long, front-border produced in semicircular lobe, with a comb of flattened hairs; palpi blunt, smooth inside; middle legs nearer at base than fore legs; tarsi knife-shaped, bent up. Abdomen flattened; segments 1 to 9 with dorsal hooks; segments 5 to 9 with lateral spines; anal appendices of equal length, sharp; the lateral ones half as long, blunt.

B. *Antennae with the third joint long, the fourth very short, linear; middle legs and fore legs equally distant; segment 10 very elongated.*

Sub-genus: **Gomphoides.** SELYS, I. e., p. 206. (Supposition.)

10. Gomphoides species.

Nympha, male. Sta Cruz, Brazil. Body long, slender; antennae 3d joint long, dilated; 4th short, linear; mask a little beyond fore legs, long; front border middle third produced in semicircular lobe; palpi hooked at tip, smooth inside; middle legs and fore legs equally distant at base; tarsi knife-shaped. Abdomen long, conical; segment 10 exceedingly long, cylindrical; segment 4 to 6 with small dorsal hooks; lateral spines on segment 7 to 9; anal appendices very short, all of equal length. (An **Aphylla brevipes** SELYS?)

11. Gomphoides species.

Nympha, female, not full grown. Rio dos Macacos, Brazil. Very similar to the foregoing; dorsal hooks on segments 4 to 9. Perhaps a sexual difference?

- C. *Antennæ 3d joint enlarged, circular; body very flat, circular; segment 10 entirely inserted in the 9th.*

Genus: **Hagenius.** SELYS, l. c., p. 238.

12. **Hagenius brevistylus.** SELYS, l. c., p. 241. Raised by T. W. Harris.

Nympha, female, full grown and young. U. S. Body very flat, enlarged; antennæ 3d joint very flat, circular; 4th rudimentary; mask reaching the fore legs, square, front-border somewhat produced; palpi blunt, smooth inside; fore legs nearer at base than middle legs. Abdomen nearly circular; dorsal hooks and lateral spines on segment 2 to 9; segment 10 very small, inserted in 9; anal appendices short, the lateral ones very small.

13. **Hagenius Japonicus.** SELYS, l. c., p. 244. (Supposition.)

Nympha, male. Kanagawa, Japan. Similar to the foregoing. Abdomen straighter at sides; dorsal hooks flattened; superior anal appendix not so deeply channelled at sides.

LEGIO III. **Lindenia.** SELYS, l. c., p. 246.

Sub-genus: **Ictinus.** SELYS, l. c., p. 263. (Supposition.)

14. **Ictinus species.** Doubtful determination.

Nympha, male and female. Himalaya, East Indies. Body short, roof-shaped; antennæ 3d joint elongated, 4th rudimentary; mask extending between the fore legs, square, front-border nearly straight; palpi rather blunt, inside finely denticulated; hind legs more distant at base; tarsi of all, 2 articulated. Abdomen ovoid, side-border sharp, denticulated in the males in segment 7 to 9; lateral spines and dorsal hooks in segment 2 to 9; segment 10 very small, inserted in 9; anal appendices short, sharp, the lateral ones a little shorter.

DIVISION II. **FISSILABIEES.** SELYS, l. c., p. 303.

The under lip cleft in the imago.

LEGIO IV. **Chlorogomphus.** SELYS, l. c., p. 311. Unknown.

LEGIO V. **Cordulegaster.** SELYS, l. c., p. 317. (Raised.)

Head transverse, oblong; eyes in the fore corners; antennæ, 7 articulated, filiform; mask extending beyond the middle legs, spoon-shaped, covering the mouth and the upper lip; legs widely and equally separated; tarsi 3 articulated; abdomen more cylindrical, tapering to the tip; the posterior suture of the segments somewhat elevated; anal appendices pyramidal.

15. **Cordulegaster Sayi.** SELYS, l. c., p. 331. (Supposition.)

Nympha, full-grown female. Chicopee and Cambridge, Massachusetts; Maryland. Tip of the mask bifid; dentation of the palpus sharp; lateral spines on segments 8 and 9; superior anal appendix nearly as long and sharp as the inferiors; lateral ones very short.

16. **Cordulegaster bidentatus.** SELYS, l. c., p. 339. (Raised by Dr. Brauer.)

Nympha, female, full grown. Europe, Vienna. Very similar to the foregoing; head more straight; no lateral spines; superior anal appendix half as long as the inferior, blunt at the tip.

17. **Cordulegaster annulatus.** SELYS, l. c., p. 333. (Supposition.)

Nympha, female, not full grown. Europe, Lüneburg. Not to be distinguished from *C. Sayi.*

LEGIO VI. **Petalura.** SELYS, l. c., p. 362. Unknown.

EXPLANATION OF THE PLATES.

PLATE I.

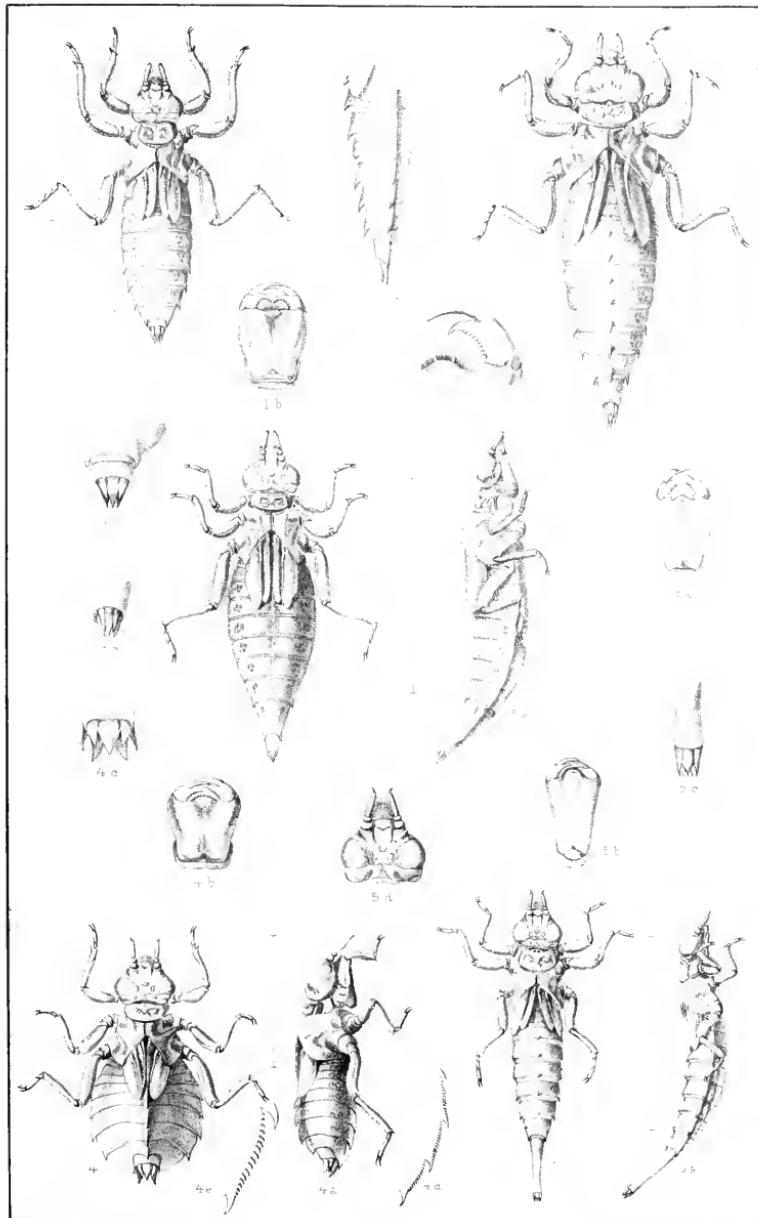
- Fig. 1. *Gomphus vnlgatissimus*; *a*, labium; *c*, appendices.
" 2. *Herpetogomphus*; *b*, labium; *c*, side view.
" 3. *Gomphus pilipes*? *a*, side view; *b*, labium; *c*, appendices.
" 4. *Ictinus*; *a*, side view; *b*, labium; *c*, appendices; *d*, lateral border of the abdomen; *e*, the same (the tip) more magnified.
" 5. *Gomphoides*, species No. 10; *a*, side view; *b*, labium; *c*, appendices; *d*, head.

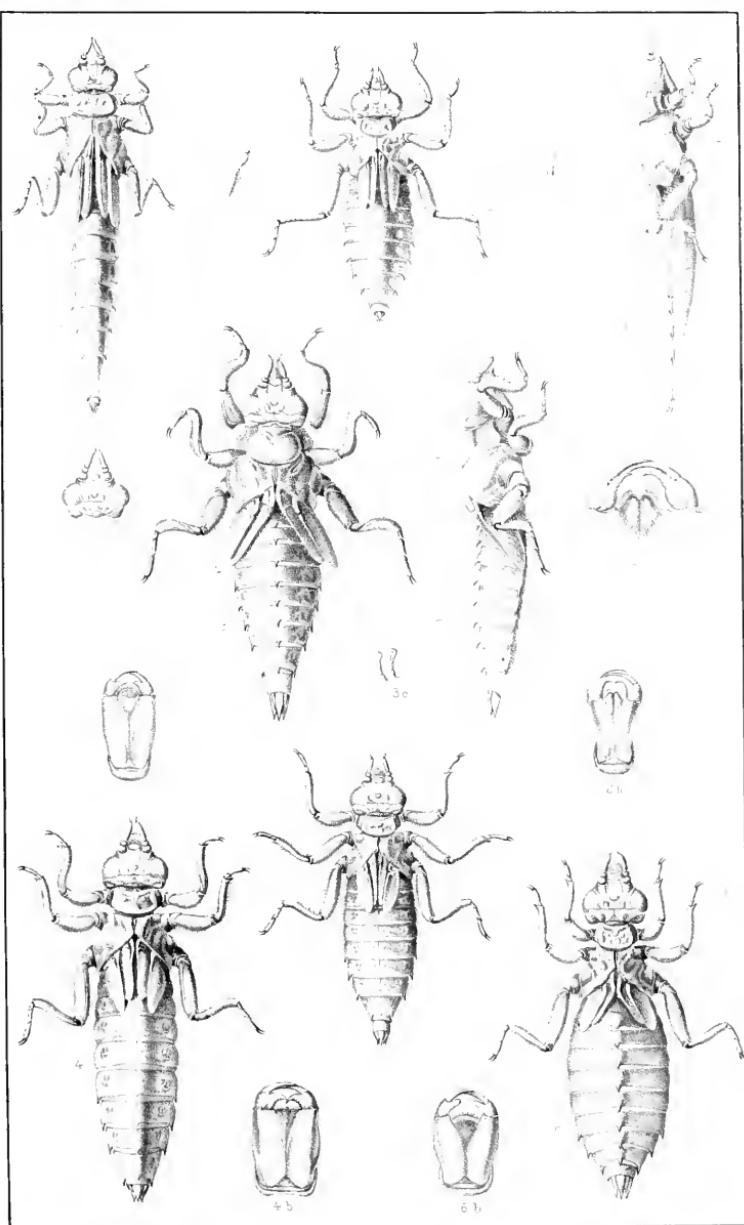
PLATE II.

- Fig. 1. *Macrogomphus spiniceps*; *a*, side view; *b*, head; *c*, two last joints of the antenna.
" 2. *Gomphus*, species No. 7; *b*, labium; *c*, the same (the tip) more magnified; *d*, bristles of the labium border.
" 3. *Progomphus*? *a*, side view; *b*, labium; *c*, bristles of the labium border.
" 4. *Gomphus*, species No. 4; *b*, labium.
" 5. *Gomphus*, species No. 5.
" 6. *Gomphus*, species No. 6; *b*, labium.

PLATE III.

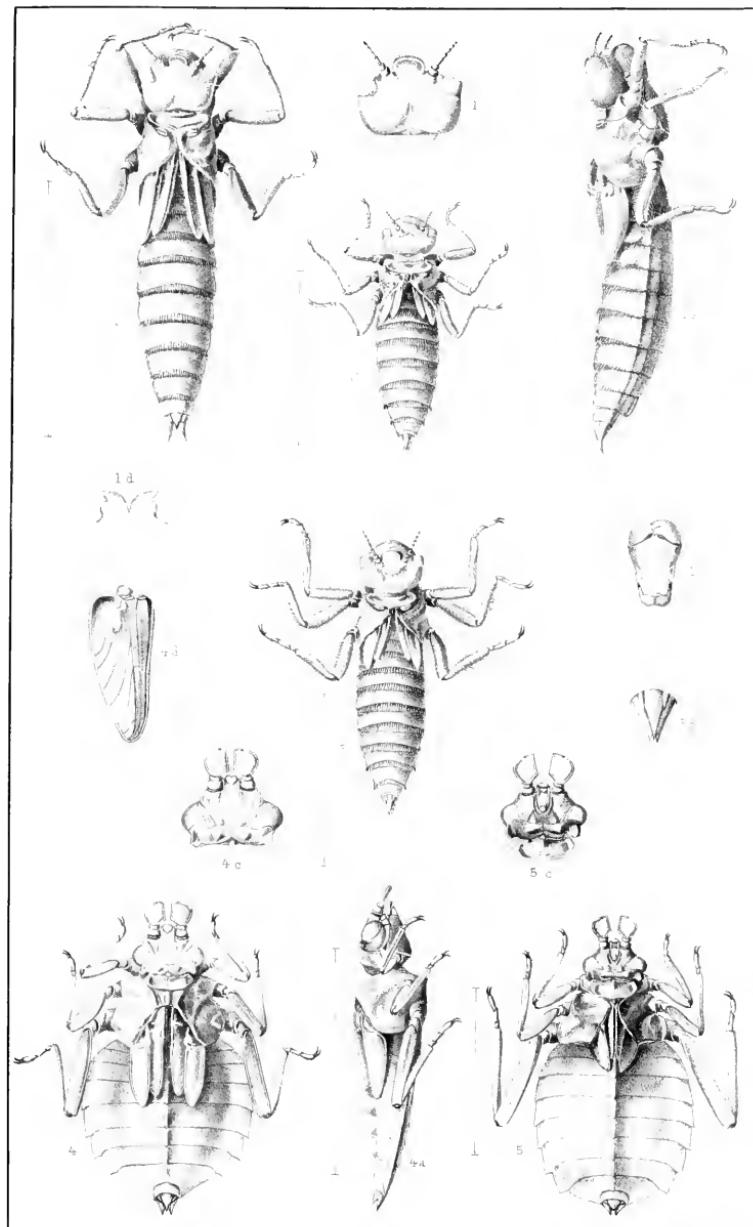
- Fig. 1. *Cordulegaster bidentatus*; *a*, side view; *b*, labium; *c*, head; *d*, bifid tip of the labium.
" 2. *Cordulegaster* Sayi.
" 3. *Cordulegaster annulatus*; *b*, appendices.
" 4. *Hagenius brevistylus*; *a*, side view; *c*, head; *d*, wing-cover.
" 5. *Hagenius Japonicus*; *c*, head.





Family Comphina

10



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